PATENT SPECIFICATION

Application Date: May 4, 1939. No. 13378/39. 528,350

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PROVISIONAL SPECIFICATION

Arrangement for Controlling Gaseous Charge Internal Combustion Engines

I, JAMES GEORGE FIFE, M.Sc.(Lond.), F.I.C., Consulting Chemist and Chartered Patent Agent, of 20 to 23, Holborn, London, E.C.1, a British Subject, do hereby declare the nature of this invention (as communicated to me by N. V. De Bataafsche Petroleum Maatschappij, of Willemstad, Curacao, Netherlands West Indies, formerly of 30, Carel van Bylandtlaan, The Hague, Holland, a Body Corporate organised under the Laws of Holland) to be as follows:—

The invention relates to an arrangement for controlling gaseous charge internal combustion engines and aims at providing an arrangement operating in such a manner that detonation in the engine is precluded or checked under any conditions.

As is known, the occurrence of detonation in an engine depends not only on the construction of the engine and the nature of the fuel used, but also on the working conditions of the engine. Several conditions are liable to affect the occurrence of detonation, for example the fuel-air ratio, the temperature of the air of the mixture, the quantity of mixture introduced into a cylinder per working stroke—which quantity in turn depends on the pressure of the air sucked in or introduced—the temperature of cylinder and piston, which depends also on the degree of cooling of the cylinder, and the moment of ignition. In general it may be said that the detonation tendency increases according as the load of the engine increases; thus, when an engine is temporarily overloaded, such as that of an aeroplane during the take-off, the risk of detonation occurs.

Now according to the invention a control arrangement is applied in which a member susceptible to detonation operates one or more of the control members of the engine in such a manner that as soon as detonation occurs, the working conditions of the engine are modified in the sense of suppressing detonation.

Since, as stated above, the occurrence of detonation depends on several conditions, the control members, the adjustment of which may lead to a suppression of the detonation, may likewise be of a widely divergent kind. The control members employed in the arrangement according to the invention may serve to modify the quantity or quality of the working medium, determined e.g. by the mixing ratio of fuel and air, the charge per stroke, the temperature of the air induced, the composition of the fuel, the quantity of special anti-knock agents added (anti-knock dopes, water). They may serve to modify the conditions of ignition and combustion in the cylinder, by changing the moment of ignition, the intensity of the cylinder cooling, the number of strokes per minute. Further they may serve to alter the load on the engine, e.g. in the case of an aero-engine driving a propeller with variable pitch by changing the pitch, which in turn involves an alteration in one or more of the above-mentioned factors.

Of the various possibilities of control use is preferably made of those which entail no or only a slight decrease in output of the engine, whilst further low fuel consumption is also maintained as much as possible. Apart from the possibilities of control afforded by changing the composition of the fuel (addition of fuel with higher anti-knock value) and addition of special agents counteracting detonation, such as anti-knock dopes and water it is therefore in particular the adjustment of the fuel to air ratio that comes into consideration, and further the timing of the ignition.

The control members to be employed in an arrangement according to the invention may be specially provided with a view to suppressing detonation; however, that is not always necessary, for in some cases the control members already present will suffice.

With the control arrangement according to the invention it is of very great importance that the member susceptible to detonation should react instan-

taneously and at incipient detonation, so that the suppression, or at any rate reduction of the detonation is attained before it has assumed harmful proportions. In this connection a member reacting to the gas vibrations in the cylinder of frequencies characteristic of detonation, which for many engines lie between about 3000 and 5000 Hertz, is particularly suitable as a member susceptible to detonation, i.e. as "Knock detector". Further for a good functioning of the apparatus it is, of course, necessary that the susceptible member should react only when detonation occurs; if, therefore, such a detector reacting to the occurrence of vibrations is applied, and this should react in a frequency range, covering besides the detonation vibrations proper also other vibrations in the engine, the detector should be combined with an apparatus preventing these other vibrations from affecting the control members.

A change of the fuel to air ratio can be effected in a simple manner by providing the carburettor with an extra jet, allowing of a richer mixture to be temporarily obtained. An embodiment of an arrangement according to the invention incorporating this feature is illustrated diagrammatically in the accompanying drawing.

Referring to the drawing, 1 represents the engine cylinder with inlet valve 2 and locally narrowed suction line 3. The cylinder is provided with a member 4, capable of converting pressure vibrations occurring in the cylinder space into electric vibrations. For this purpose an indicator with piezo-electric crystals having a high natural frequency is particularly suitable, although other types of indicators, e.g. with variable resistance, variable capacity or variable magnetic induction, may also be employed. The electric vibrations emanating from the indicator are conducted to an apparatus 5, where they are amplified and the vibrations not caused by detonation are filtered out or suppressed, so that only the vibrations within a frequency range of e.g. about 3000—5000 Hertz and originating from detonation are left. If desired this apparatus may be provided with a rectifier and a measuring device showing the degree of detonation. The output current from apparatus 5 is fed to a relay 6, which, as soon as detonation occurs, closes circuit 7 containing a source of current 8 and a solenoid 9. The fuel content in the air-fuel mixture sucked in is controlled as follows:

Besides the normal jet conduit 11 another conduit 12 with auxiliary jet leads from the float chamber 10 of the carburettor to the narrowed part of the suction line 3. In the conduit 12 a control valve 13 is disposed which is adjusted by turning the lever 14. A piston 16 linked to this lever is pressed upwards by the spring 18. The piston 16 is adapted to move in a cylinder 17 filled with liquid and has a small opening provided with a valve with leak, so that its movement is damped, the damping effect being greatest with upward movement.

The lever 14 has further attached to it the soft iron core of the solenoid 9 in such a manner that if current flows through circuit 7, the core is pulled down. Normally the lever is in its top position, the valve 13 being closed. As soon as detonation occurs, in the engine the core 15 is pulled down owing to the flow of current through the solenoid 9, and the lever 14 turns downward, thus opening valve 13.

As a result of the extra fuel supply through conduit 12 a richer mixture is then obtained, which, as is known, shows less tendency to knock.

As soon as the detonation ceases, the valve is slowly closed again by the action of spring 18 and piston 16.

The above describes only one example of the numerous ways in which an apparatus according to the invention can be constructed.

In each individual case it should be ascertained which control device can be adjusted most advantageously by the knock detector and in what manner this adjustment is to be combined, if desired, with the methods of control, either automatic or manual, already provided for.

It may be of particular advantage to apply a servo-motor for coupling the member susceptible to detonation with the control member, with a view to assuring that it is not the position of the control member, but the change of said position that is determined by the detonation.

In the above described embodiment reference is made to a single cylinder. Since with a multi-cylinder engine the detonation as a rule will not occur simultaneously in the various cylinders, each cylinder will generally be provided with an indicator and the adjustment of the control member of the engine will be made to depend either on the degree of detonation in the cylinder in which the detonation is strongest or on the average degree of detonation of all cylinders.

This purpose can be attained particularly with the first mentioned method, by switching in the various indicators in rapid succession.

Dated this 4th day of May, 1939.

ELKINGTON & FIFE,
Consulting Chemists and
Chartered Patent Agents,
20 to 23, Holborn, London, E.C.1,
Agents for the Applicant.

COMPLETE SPECIFICATION

Arrangement for Controlling Gaseous Charge Internal Combustion Engines

I, JAMES GEORGE FIFE, M.Sc.(Lond.), F.I.C., Consulting Chemist and Chartered Patent Agent, of 20 to 23, Holborn, London, E.C.1, a British Subject, do hereby declare the nature of this invention and in what manner the same is to be performed, (as communicated to me by N. V. De Bataafsche Petroleum Maatschappij, of Willemstad, Curacao, Netherlands West Indies, formerly of 30, Carel van Bylandtlaan, The Hague, Holland, a Body Corporate organised under the laws of Holland, to be particularly described and ascertained in and by the following statement:—

The invention relates to an arrangement for suppressing detonation in an internal combustion engine.

As is known, the occurrence of detonation in an engine depends not only on the construction of the engine and the nature of the fuel used, but also on the working conditions of the engine. Several conditions are liable to affect the occurrence of detonation, for example the fuel-air ratio, the temperature of the air of the mixture, the quantity of mixture introduced into a cylinder per working stroke—which quantity in turn depends on the pressure of the air sucked in or introduced—, the temperature of cylinder and piston, which depends also on the degree of cooling of the cylinder, and the moment of ignition. In general it may be said that the detonation tendency increases according as the load of the engine increases; thus, when an engine is temporarily over-loaded, such as that of an aeroplane during the take-off, the risk of detonation occurs.

Now according to the invention a control arrangement is applied in which a member susceptible to detonation operates one or more of the control members of the engine in such a manner that as soon as detonation occurs, the working conditions of the engine are modified in the sense of suppressing detonation.

Since, as stated above, the occurrence of detonation depends on several conditions, the control members, the adjustment of which may lead to a suppression of the detonation, may likewise be of a widely divergent kind. The control members employed in the arrangement according to the invention may serve to modify the quantity or quality of the working medium, determined e.g. by the mixing ratio of fuel and air, the charge per stroke, the temperature of the air induced, the composition of the fuel, the quantity of special anti-knock agents added (anti-knock dopes, water). They may serve to modify the conditions of ignition and combustion in the cylinder, by changing the moment of ignition, the intensity of the cylider cooling, the number of strokes per minute. Further they may serve to alter the load on the engine, e.g. in the case of an aero-engine driving a propeller with variable pitch by changing the pitch, which in turn involves an alteration in one or more of the above-mentioned factors.

Of the various possibilities of control use is preferably made of those which entail no or only a slight decrease in output of the engine, whilst further low fuel consumption is also maintained as much as possible. Apart from the possibilities of control afforded by changing the composition of the fuel (addition of fuel with higher anti-knock value) and addition of special agents counteracting detonation, such as anti-knock dopes and water it is therefore in particular the adjustment of the fuel to air ratio that comes into consideration, and further the timing of the ignition.

The control members to be employed in an arrangement according to the invention may be specially provided with a view to suppressing detonation; however, that is not always necessary, for in some cases the control members already present will suffice.

With the control arrangement according to the invention it is of very great importance that the member susceptible to detonation should react instantaneously and at incipient detonation, so reduction of the detonation is attained before it has assumed harmful proportions. In this connection a member reacting to the gas vibrations in the cylinder of frequencies characteristic of

detonation, which for many engines lie between about 3000 and 5000 Hertz, is particularly suitable as a member susceptible to detonation, i.e. as "Knock detector". Further for a good functioning of the apparatus it is, of course, necessary that the susceptible member should react only when detonation occurs; if, therefore, such a detector reacting to the occurrence of vibrations is applied, and this should react in a frequency range, covering besides the detonation vibrations proper also other vibrations in the engine, the detector preventing these other vibrations from affecting the control members.

A change of the fuel to air ratio can be effected in a simple manner by providing the carburettor with an extra jet, should be combined with an apparatus allowing of a richer mixture to be temporarily obtained. An embodiment of an arrangement according to the illustrated diagrammatically in the invention incorporating this feature is drawing accompanying the Provisional Specification.

Referring to the drawing, 1 represents the engine cylinder with inlet valve 2 and locally narrowed suction line 3. The cylinder is provided with a member 4, capable of converting pressure vibrations occurring in the cylinder space into electric vibrations. For this purpose an indicator with piezo-electric crystals having a high natural frequency is particularly suitable, although other types of indicators, e.g. with variable resistance, variable capacity or variable magnetic induction, may also be employed. The electric vibrations emanating from the indicator are conducted to an apparatus 5, where they are amplified and the vibrations not caused by detonation are filtered out or suppressed, so that only the vibrations within a frequency range of e.g. about 3000—5000 Hertz and originating from detonation are left. If desired this apparatus may be provided with a rectifier and a measuring device showing the degree of detonation. The output current from apparatus 5 is fed to a relay 6, which, as soon as detonation occurs, closes circuit 7 containing a source of current S and a solenoid 9. The fuel content in the air-fuel mixture sucked in is controlled as follows:

Besides the normal jet conduit 11 another conduit 12 with auxiliary jet leads from the float chamber 10 of the carburettor to the narrowed part of the suction line 3. In the conduit 12 a control valve 13 is disposed which is adjusted by turning the lever 14. A piston 16 linked to this lever is pressed upwards by the spring 18. The piston 16 is adapted to move in a cylinder 17 filled with liquid and has a small opening provided with a valve with leak, so that its movement is damped, the damping effect being greatest with upward movement.

The lever 14 has further attached to it the soft iron core 15 of the solenoid 9 in such a manner that if current flows through circuit 7, the core is pulled down. Normally the lever is in its top position, the valve 13 being closed. As soon as detonation occurs, in the engine the core 15 is pulled down owing to the flow of current through the solenoid 9, and the lever 14 turns downward, thus opening valve 13.

As a result of the extra fuel supply through conduit 12 a richer mixture is then obtained, which, as is known, shows less tendency to knock.

As soon as the detonation ceases, the valve is slowly closed again by the action of spring 18 and piston 16.

The above describes only one example of the numerous ways in which an apparatus according to the invention can be constructed.

In each individual case it should be ascertained which control device can be adjusted most advantageously by the know detector and in what manner this adjustment is to be combined, if desired, with the methods of control, either automatic or manual, already provided for.

It may be of particular advantage to apply a servo-motor for coupling the member susceptible to detonation with the control member, with a view to assuring that it is not the position of the control member, but the change of said position that is determined by the detonation.

In the above described embodiment reference is made to a single cylinder. Since with a multi-cylinder engine the detonation as a rule will not occur simultaneously in the various cylinders, each cylinder will generally be provided with an indicator and the adjustment of the control member of the engine will be made to depend either on the degree of detonation in the cylinder in which the detonation is strongest or on the average degree of detonation of all cylinders.

This purpose can be attained particularly with the first mentioned method, by switching in the various indicators in rapid succession.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed (as communicated to me from abroad), I declare that what I claim is:—

1. An arrangement for suppressing detonation in an internal combustion engine, wherein a member susceptible to detonation operates one or more of the control members of the engine in such a manner that as soon as detonation occurs the working conditions of the engine are modified in the sense of suppressing detonation.

2. An arrangement as claimed in claim 1, in which the member susceptible to detonation is an electrical member adapted to convert pressure vibrations of frequencies characteristic of detonation occurring in the cylinder space into electrical vibrations, said electrical vibrations being used to cause an electrical current by means of which the control member or members of the engine is or are adjusted.

3. An arrangement as claimed in claim 2 for use with a multi-cylinder engine, in which a member susceptible to detonation is provided for each of the cylinders or cylinder ends, these members being switched in one after the other in rapid succession, in such a manner that the control member or members is or are operated in dependence on the detonation in such cylinder where it is strongest.

4. An arrangement as claimed in claim 2 for use with a multi-cylinder engine, in which a member susceptible to detonation is provided for each of the cylinders or cylinder ends, these members being connected in such a mannen to the remainder of the arrangement that the control member or members is or are operated in dependence on the average degree of detonation.

5. An arrangement for suppressing detonation in an internal combustion engine substantially as described with reference to the accompanying drawing.

Dated this 8th day of May, 1940.

ELKINGTON & FIFE,
Consulting Chemists and
Chartered Patent Agents,
20 to 23, Holborn, London, E.C.1,
Agents for the Applicant.

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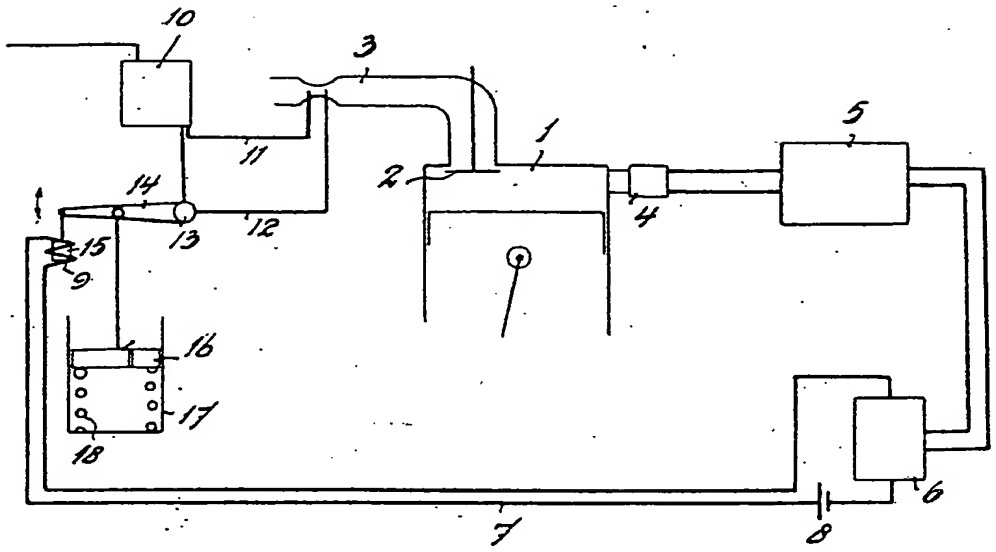

[This Drawing is a reproduction of the Original on a reduced scale.]

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